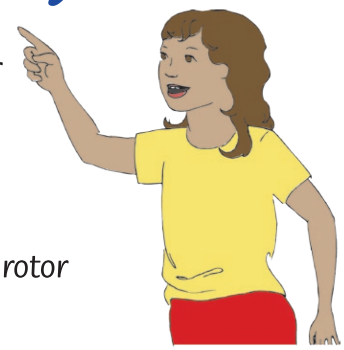
Exploration 2: How Do Rotorcraft Fly?

Students choose a model and use it to explore rotorcraft flight. They use a "fair test" and conclude that a spinning rotor is required for a rotorcraft to fly.



Main Concept

The process of scientific inquiry can be used to discover that a spinning rotor provides the lift necessary for rotorcraft flight.

Goal

Students will conduct a scientific investigation of rotorcraft flight and conclude that a spinning rotor is necessary for a rotorcraft to fly.

Objectives and Standards

Objectives	*Standards*
1. *Students will use a model to conduct an investigation in rotorcraft flight.* 2. *Students will describe the purpose of a rotorcraft's rotor blades.* 3. *Students will explain the difference between the effects of a spinning rotor and a non-spinning rotor on a rotorcraft model.* 4. *Students will develop abilities necessary to do scientific inquiry.* 5. *Students will develop an understanding of scientific inquiry*	**Partially Meets:** NSES: A (K-4) #1, #2 **Addresses**: 2061: 1B (K-2) #1 2061: 1B (3-5) #1

Prerequisite Concepts

- *A scientific model is an object or idea used to understand something about the real thing.*

- *A model of an airplane can be used to understand how a plane flies.*

Links to Resources that Address Prerequisite Concepts

See Robin Whirlybird Exploration #1: What is a model?

New Concepts

- *A spinning rotor is required for a rotorcraft to fly.*

- *People can often learn about things around them by just observing those things carefully, but sometimes they can learn more by doing something to the things and noting what happens.*

- *Scientific investigations may take many different forms, including observing what things are like and doing experiments.*

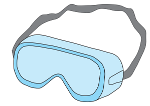
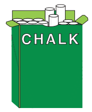
Links to Lessons and Resources that Also Address Concepts

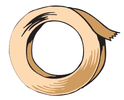
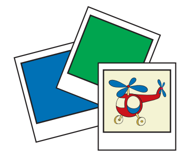
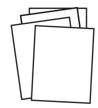
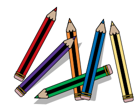
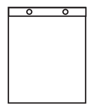
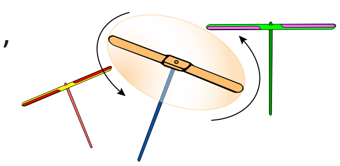
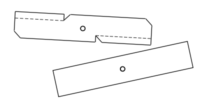
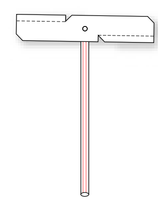
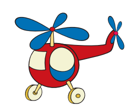
- *Web sites:*
  Robin Whirlybird
  http://rotored.arc.nasa.gov/story/robin18.html
  http://rotored.arc.nasa.gov/story/robin3.html
  Click the "Rotorcraft Activities" button.

Schedule

Allow 2-4 sessions of 20-30 minutes each.

Materials

- Protective eyewear for each student, available from most school science supply stores and catalogs 
- Chalk or tape 


- Photos or pictures of different types of rotorcraft (helicopters), available at: http://ails.arc.nasa.gov/Images/Aeronautics/index.html#rotor 
- Drawing paper and crayons or coloring pencils   
- Chart paper 
- One "flying dragonfly," which is a toy rotor that flies (shown right), for each pair of students 
- Lightweight paper propeller made using the template in this chapter's appendix
- Heavyweight paper propeller made using the template in this chapter's appendix 
- Drinking straw with the lightweight paper propeller securely taped to one end 
- Drinking straw with the heavyweight paper propeller securely taped to one end
- Miniature plastic toy helicopter, available from most toy stores 

Safety Precautions

When using flying objects in a classroom, post very strict rules and review them with the students. All students MUST wear protective eyewear while any object is in flight. Clearly delineate one or more staging areas, preferably with students' input. Mark on the ground with chalk or tape, where all "test flights" will take place. Caution students to "secure the area" before beginning any "test flight."

Engage

1. Draw on students' prior knowledge of rotorcraft by asking them:
   - Have you seen helicopters or rotorcraft?
   - Where have you seen them?
   - What were they doing?
   - What kind were they?
   - What did you notice about them?

   Students will probably say that they have seen rotorcraft in real life or on television. They may have seen rotorcraft used by radio or television crews checking on traffic, or by the police and other organizations. They may observe that rotorcraft have rotating blades and make noise.

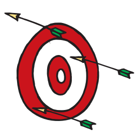
2. Show various pictures of rotorcraft.
   Question: "What do these rotorcraft have in common?"

3. Write students' responses on chart paper as they point out the similarities of the rotorcraft.

4. Distribute drawing paper and crayons.

5. Ask students to create an illustration that explains how they believe a rotorcraft flies.
   Note to Teacher: This is their scientific hypothesis; however, at the kindergarten through 2nd grade level it is unnecessary to use this terminology.

6. Have each student show their illustration and give their explanation of how rotorcraft fly.

7. 
   Address common misconceptions such as the following:
   - Aircraft are held up in the air by giant sky hooks or ropes.
   - Aircraft are held aloft by the wind.

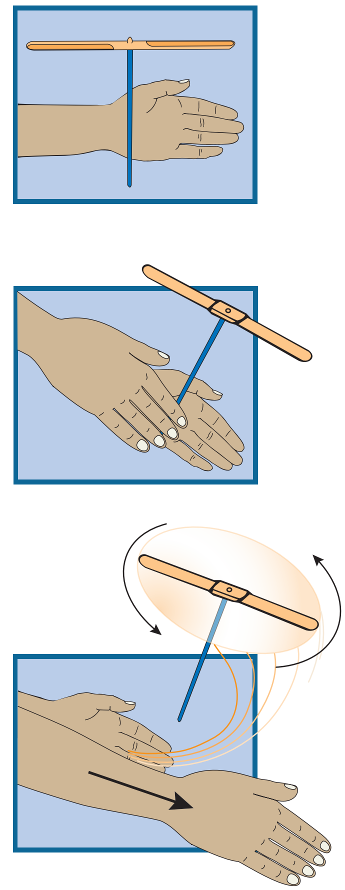
   Ask students if they can see anything holding up the rotorcraft or if the rotorcraft would fly if there were no wind.

8. Segue into how scientists explore ideas and phenomena using models. Remind students of the previous exploration, where they learned what a model really is and how models help us understand something about the real thing.

9. Ask students what could be used as a model of a rotorcraft and compile a short list. Include the "flying dragonfly" toy rotor (pictured in the "Materials" list).
   Say: We will now choose a model to explore what it is that makes a rotorcraft fly.

Explore

Explore Part A: Students choose a model to explore rotorcraft flight.



How to fly your flying dragonfly.

1. Display the "flying dragonfly" toy rotors, drinking straws with propellers attached, propellers and miniature plastic toy helicopters listed in the "Materials" section.

2. Have students work in teams or pairs.

3. Set safety precautions before the students start to explore!

4. **Questions**:
   - Which one of these objects would be a good model to use to find out how rotorcraft fly?
   - What can you do to find out?

   Allow 10 minutes for open exploration.

5. Circulate through the group, recording students' observations, actions, ideas and questions. Your records will become the basis for further explorations and discussions.
   - Monitor safety and proper use of materials.

6. Have students in pairs draw a picture that depicts the results of their models and their flights.

7. Gather students together for a discussion.
   Question: What did you notice about flying with this model?
   Focus on each model in turn.

8. **Question**: Which model is the best to use to learn about rotorcraft?
   Note to Teacher: Students should conclude that the "flying dragonfly" toy propeller (pictured in the "Materials" list) is the best model unless they develop other models that work as well. The rotor blades on the "flying dragonfly" toy propeller are shaped to create maximum lift and the "fuselage" is lightweight yet sturdy enough to "hold cargo."

Explore Part B: Students use their model to explore rotorcraft flight.

1. Review with students the previous days' explorations regarding rotorcraft, models and flight as well as any questions posed.

2. Explain to the students that based upon their previous observations, today they will conduct experiments (like scientists) using their model (the "flying dragonfly" toy propeller or other model that they build that works as well).

   - ***Say***: Yesterday we noticed that this model was one of the better models for flight. Today I want you to see what happens when you hold this model in different ways and let it go.

   - ***Question***: What kind of different ways can we hold the model before we release it?
     Have a few students demonstrate their technique using a drinking straw with propeller attached.

   - ***Question***: How can we make this a fair test?

   Note to Teacher: In the primary grades students use the concept of "fair testing." A "fair test" is an investigation involving two variables in which one of the variables is controlled by the researcher (i.e. the students). Through a series of fair tests during which students manipulate the variables, they revise their own hypotheses (or theories about the world or even scientific misconceptions) based on earlier observations and move their thinking in the direction of conventional scientific ideas. A fair test is performed a prescribed number of times to authenticate its predictability. Students can set the number of repetitions performed, which usually ranges between 3 and 5.

3. ***Question***: Why is it important to make this a fair test?
   Answer: A fair test is one where we change just one aspect of the flight, like the height from which the model is released. If the test was not "fair," and we changed many things about the flight, then we would not know which of our changes affected the flight.

4. Solicit ideas and direct focus toward holding the model the same distance from the ground each time. Also, key students in on testing in an area without moving air.

5. Students will most probably spin the rotor before releasing the model. Ask them what would happen if everything stayed the same and they did not spin the rotor.

6. Ask students how many times they should perform each test, and have the group come to consensus on the number of tests per position.

7. Ask students what they think they might find out.

8. Record students' hypotheses on chart paper for class viewing.

9. Have students draw the holding position for each test and the model's flight path for each position tested.

10. Give students 10 minutes to explore these questions/positions. Upon completion, discuss their findings.

Explain

1. After students perform their explorations have them display their drawings while discussing their findings.

2. Direct their focus with the following questions.

   Question: What is the difference between not spinning the rotor and spinning the rotor?
   Answer: When the rotor spins the model flies and gradually falls to the ground. When the rotor is not spinning the model does not fly and falls to the ground.

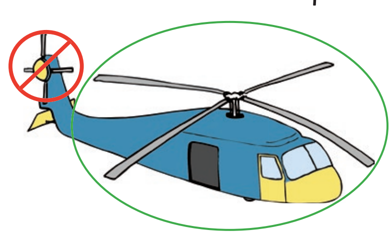
   Question: When you held the model in different positions and then made it spin, what happened? Was there a difference? If so, describe the difference.
   Answer: When the model is held upright, the rotor blades work the most efficiently. When the model is released from other positions it falls to the ground.

   Question: What part of this model makes it "fly"? (Use the students' terminology to describe the model's flight.)
   Answer: The spinning rotor makes the model fly.

Evaluate

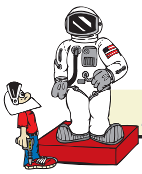
1. Distribute drawing paper and ask students to draw a picture of a rotorcraft flying.
   Students' pictures should include the body of the rotorcraft (or fuselage) and the main rotors.

2. Ask students to circle the part of the rotorcraft that causes the rotorcraft to fly.
   Students should circle the main rotors. Some students may circle the tail rotor as well. Explain to these students that the tail rotor stabilizes the rotorcraft.



3. In the “Explain” segment of this activity, students should be able to explain that a spinning rotor causes a rotorcraft to fly.

4. Have students use arrows to show how the rotors generate lift.
   Students should draw arrows from the rotor blades pointing down towards the ground, indicating the movement of air, and lines above the rotor blades indicating the upward movement of the rotorcraft.



Further Exploration

Students might have additional questions regarding the connection between how fast the rotor blades turn with how long the rotorcraft stays in the air and/or how high it flies. Ideally, students will suggest that there is “something” in the air that the rotor is affecting that generates the lift force. They may mention the air movement caused by the spinning rotor. Listen and record any new questions that spring from this exploration. Post on chart paper and examine these questions later for possible explorations. If time and interest permits, transform their ideas, questions, observations and/or hypotheses into another investigation.

Appendix: Propeller Template